SCH 4U1

NAME: Answer key
DATE: May 20

CHAPTER 7 QUIZ
CHEMICAL SYSTEMS & EQUILIBRIUM

Knowledge /10	Inquiry /30

PART B: SHORT ANSWER QUESTIONS

Answer the following questions in the space provided.

11. For the reaction below,

$2NO_2(g) \Leftrightarrow 2NO(g) + O_2(g)\uparrow + E \qquad \Delta H = -441.6\ kJ$

in which direction will the equilibrium shift, with the following changes (give a reason for each) (10 MARKS):

(a) oxygen is added

→ Rx ← (1)

→ to offset the ↑ in O_2 & produce more reactants (2)

(b) nitrogen monoxide is removed

→ Rx → (1)

→ to replace the lost NO (2)

(c) energy is added

- Rx shifts left (1)
- moves to the side of the reaction where the energy term isn't to produce less Energy/heat (2)

(d) volume is increased

→ ↑V ↓P ∴ Rx → (1)

→ to make up for the decreased pressure the reaction will shift to the side with more gas moles (2)

(e) catalyst is added

→ no effect (1)

→ will speed up the time it takes to reach eq'm but not where the rxn will proceed to.

12. For the following reaction, the equilibrium constant Keq is 9 at 460°C.

$$CO_2(g) + NO(g) \Leftrightarrow NO_2(g) + CO(g)$$

Initially, a 2.0 L flask contains 4.0 mol each of all four reagents. Calculate the equilibrium concentrations of carbon dioxide and carbon monoxide at this temperature. (7 MARKS)

	$CO_2(g)$	+ $NO(g)$	⇌ $NO_2(g)$	+ $CO(g)$
i	2.0	2.0	2.0	2.0
c	−x	−x	+x	+x
e	2.0−x	2.0−x	2.0+x	2.0+x

① ② ? $[CO_2]_e$? $[CO]_e$?

③

④ $[CO_2]_i = [NO]_i = [NO_2]_i = [CO] = \frac{4.0\ mol}{2.0\ L} = 2.0\ M$

⑤ $K_{eq} = \frac{[NO_2][CO]}{[CO_2][NO]}$

$= \frac{(2.0+x)(2.0+x)}{(2.0-x)(2.0-x)}$

$K_{eq} = \frac{(2.0+x)^2}{(2.0-x)^2}$

$\sqrt{9} = \sqrt{\frac{(2.0+x)^2}{(2.0-x)^2}}$

$3 = \frac{2.0+x}{2.0-x}$ ⑥

$6 - 3x = 2.0 + x$

$4.0 = 4x$

$x = 1.0$

$\therefore [CO_2]_e = 2.0\ M - 1.0\ M$ ✗

$= 1.0\ M$

⑦

$[CO]_e = 2.0M + 1.0M$ ✗

$= 3.0\ M.$

13. What is the value of K_{sp} for barium hydroxide if the concentration of this compound in solution is 1.47×10^{-4} mol/L? (6 MARKS)

$Ba(OH)_2 \rightleftharpoons Ba^{+2}_{(aq)} + 2OH^-_{(aq)}$ ① $K_{sp} = ?$

$[Ba(OH)_2] = 1.47 \times 10^{-4}$ mol/L $= [Ba^{+2}]$ ②

$[OH^-] = 2[Ba^{+2}]$ ③

$= 2(1.47 \times 10^{-4})$ mol/L

$= 2.94 \times 10^{-4}$ mol/L ④

$K_{sp} = [Ba^{+2}][OH^-]^2$ ⑤

$= (1.47 \times 10^{-4}\ \text{mol/L})(2.94 \times 10^{-4}\ \text{mol/L})^2$

$= 1.27 \times 10^{-11}$ ⑥

14. Will a precipitate form if 30.0 mL of 1.5×10^{-4} mol/L magnesium chloride is added to 30.0 mL of 2.0×10^{-4} mol/L silver nitrate? (7 MARKS)

? will precipitate form

$MgCl_2(aq) + 2AgNO_3(aq) \rightleftharpoons Mg(NO_3)_2 + 2AgCl(s)$ (1)

Net ionic equation: $2AgCl(s) \rightleftharpoons 2Ag^+(aq) + 2Cl^-(aq)$ (2)

$K_{sp} = [Ag^+(aq)]^2[Cl^-(aq)]^2$ (3)

Ag^+ $2AgNO_3(aq) \rightleftharpoons 2Ag^+(aq) + 2NO_3^-(aq)$ (4)

$[AgNO_3] = [Ag^+] = 2.0 \times 10^{-4}$ mol/L

$2.0 \times 10^{-4}\ M \times \frac{30.0\ mL}{60.0\ mL} = 1.0 \times 10^{-4}\ M$

Cl^- $MgCl_2(aq) \rightarrow Mg^{+2}(aq) + 2Cl^-(aq)$

$[Cl^-] = 2[MgCl_2]$

$= 2(1.5 \times 10^{-4}\ M)$ (5)

$= 3.0 \times 10^{-4}$ mol/L

$3.0 \times 10^{-4}\ M \times \frac{30.0\ mL}{60.0\ mL} = 1.5 \times 10^{-4}\ M.$

$Q = [Ag^+][Cl^-]$

$= (1.0 \times 10^{-4}\ M)(1.5 \times 10^{-4}\ M)$ (6)

$= 1.5 \times 10^{-8}$

$K_{sp} = 1.8 \times 10^{-10}$

$\therefore Q > K$ ppt will form (7)